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FRIDAY, FEBRUARY 24, 1899.

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*THE RECENTLY DISCOVERED GASES AND THEIR RELATION TO THE PERIODIC LAW.**

GENTLEMEN: It is well known to you all how the remarkable observation of Lord Rayleigh that nitrogen from the atmosphere possesses a greater density than that prepared from ammonia or nitrates led to the discovery of argon, a new constituent of the air. I need not say that had it not been for this observation the investigations of which I shall speak this evening would never have been carried out, at least not by me. You also, doubtless, will remember that the search for some compound of argon was rewarded, not by the attainment of the quest, but by the discovery, in clèvite and other rare uranium minerals, of helium, an element whose existence in the chromosphere of the sun had already been suspected. And, further, I hardly need to recall to your minds that the density of helium is in round numbers 2, and that of argon 20, and that the ratio of specific heats of both these gases, unlike that of most others, is 1.66.

From these figures it follows that the atomic weight of helium is 4 and that of argon 40. It is true that in many quarters this conclusion is not admitted, but I have always thought it better to recognize the

*Address delivered by Professor William Ramsay before the Deutschen chemischen Gesellschaft, December 19, 1898. Translated by J. L. H.

validity of the theory of gases and accept the logical deductions than to deny the truth of the present theories. The only reason for not admitting the correctness of these atomic weights is that that of argon is greater than that of potassium, but this is no severer attack upon the validity of the periodic law than the accepted position of iodin after, instead of before, tellurium. As a matter of fact, all the more recent determinations of the atomic weight of tellurium give the figure 127.6, while that of iodin remains unchanged at 127.

Since these new elements form no compounds, it is not possible to decide the question by purely chemical methods. Were it only possible for us to prepare a single volatile compound of helium or of argon our problem would be solved. In spite of many attempts, I have not been able to confirm Berthelot's results with benzene or carbon bisulfid. I have, however, offered to place a liter of argon at the disposal of my distinguished colleague, that he may repeat his experiments on a larger scale. No one can doubt that it is exceedingly desirable that the question of these atomic weights should be finally decided and that by chemical methods.

In order that the subject may not depend wholly on physical theories, I have considered it from another standpoint. If we assume, as from countless chemical facts we are fully justified in doing, that the periodic law is true, then, giving helium the atomic weight 2 and argon 20, there is no possible place for an element of their mean atomic weight; for, unless we absolutely overturn the accepted views, there is no vacancy in the table for such an element. This appears from the following portion of the table:

H = 1 He = 2(?) Li = 7 Gl = 9·2 B = 11 C = 12
N = 14 O = 16 F = 19 A = 20(?)

It is true there is space enough between He = 2 and Li = 7, but it is highly improbable that an element belonging to the argon-series could have so low an atomic weight. The difference between adjacent members of the same group of elements is generally from 16 to 18 units, but here such a difference is wholly excluded. If, on the other hand, we assume He = 4 and A = 40, it would be, in my opinion, by no means improbable that such an element could exist whose atomic weight would be somewhere about 16 units greater than that of helium, and consequently 20 units less than that of argon. The discovery of such an element would be, therefore, not only a proof of the correctness of 40 as the atomic weight of argon, but also a confirmation of the present views regarding the significance of the specific heats of gases for their molecular weight.

A glance at the periodic table will make these considerations clear, for in the latter case we have the following series:

Li = 7 Gl = 9.2 B = 11 C = 12 N = 14
Na = 23 Mg = 24.3 Al = 27 Si = 28 P = 31
He = 4
O = 16 F = 19 (?) = 20
S = 32 Cl = 35.5 A = 40

Shortly after the discovery of helium I began the search for this suspected element of atomic weight of about 20, at first in connection with Dr. Collie, my former assistant, and later with my present assistant, Dr. Travers.

At first it appeared not improbable that this element might be found in those uranium minerals from which helium had been obtained. We did not, however, confine ourselves to these minerals, but tested all available minerals either by heating in a vacuum or by fusion with sodium bisulfate. In many of these minerals helium was found; in many, on the other hand, only traces of hydrocarbons and hydrogen. One mineral only, malakon, gave sufficient argon to be recognizable by the spectroscope; the others which contained helium

gave off generally also a trace of argon, as was later shown by our diffusion experiments. Naturally, it was impossible to be certain that the few cubic centimeters of gas which we collected from these minerals contained no new gas, but we failed to detect the presence of any new lines with the spectroscope.

You will, undoubtedly, recall that, soon after the discovery of helium, doubts were expressed in many quarters as to whether the gas was really uniform or a mixture. In order to dispel these doubts and also to search for the missing gas, Dr. Collie and I carried out a long series of diffusion experiments. Through these we reached the conclusion that it was, in fact, possible to separate helium into two constituents, one of which possessed a somewhat higher density than the other. Later experiments, however, in conjunction with Dr. Travers, showed that this conclusion was erroneous. In this second series much larger quantities of helium were at our disposal, and, to our disappointment, we found that the heavier fractions of our gas owed their greater density to the presence of a trace of argon. Here, again, we were unable to find any new line in the spectrum, and thus far our search was fruitless.

We next directed our attention to meteorites and to mineral waters. Only one out of seven meteorites examined by Dr. Travers and myself showed the presence of helium and with it a trace of argon; the others gave only hydrogen and hydrocarbons, which were also present in the gases from the meteorite which contained helium and argon. Here, again, our search was in vain. The mineral water from Bath has been investigated by Lord Rayleigh; in the waters from Cantarets, in the Pyrenees, Dr. Schlösing has found both argon and helium. Dr. Travers and I examined these gases for new lines, but, as before, none were found.

Our patience was now well-nigh exhausted. There seemed, however, to be a single ray of hope left, in an observation which had been made by Dr. Collie and myself. You will recall that the atomic weight of argon was apparently too high; at all events, it would be more in harmony with the periodic law if the density of argon were 19 instead of 20, and hence its atomic weight 38 instead of 40. Hence, after some fruitless attempts to separate argon into more than one constituent by means of solution in water, we undertook a systematic diffusion of argon. We did not, however, carry this procedure very far, for, at that time, we believed that helium was a more probable source of the desired gas; nevertheless, we found a slight difference in density between the gas which diffused first and that which remained undiffused. We, therefore, decided to prepare a large quantity of argon, and, after liquefying it, to investigate carefully the different fractions on distillation.

Such an operation demands much time. In the first place, the necessary apparatus is not to be found in any ordinary chemical laboratory; the preparation cannot be carried out in glass tubes in an ordinary furnace, but requires iron tubes of large size and an especial furnace; in the second place, the operation must be repeated several times, for it is not convenient to work with an excessively large quantity of magnesium. As before, we removed the oxygen from the air by means of copper at a red heat; the atmospheric nitrogen remaining was collected in a large gasometer holding about 200 liters; after drying over concentrated sulfuric acid and phosphorus pentoxid, the gas was passed through an iron tube of 5 cm. diameter, filled with magnesium filings; the gas was then passed through a second copper oxid tube to remove the hydrogen; it then entered a galvanized-iron gasometer, which was constructed like an ordinary illuminating-gas gasometer, in or-

der that the argon should come in contact with as little water as possible, since argon is quite appreciably soluble in water, and, had the ordinary form of gasometer been used, much would have been lost in this way. Again, the gas had to be led over hot magnesium to reduce still further the quantity of nitrogen; and at last it was circulated between the gasometers, passing on its way through a mixture of thoroughly heated lime and magnesia at a red heat. This is a means of absorption, recommended by Maquenne, to remove the last of nitrogen. Since, however, it is not possible to dry the lime absolutely, hydrogen is taken up by the gas, and this must again be removed by copper oxid, in order that all the hydrogen may be burned, after which the water must again be removed by drying tubes.

These operations required several months and were chiefly directed by Dr. Travers.

Meanwhile, it seemed to be worth while to make an examination as to whether the desired gas might possibly form compounds and be united with the magnesium, by which the nitrogen had been removed. Miss Emily Aston assisted me to settle this question.

Some 700 grams of the magnesium nitrid were, for this purpose, treated with water in a large exhausted flask, in such a manner that the evolved ammonia was absorbed in dilute sulfuric acid which had been thoroughly boiled; all the other gases were collected by a Töpler pump. The total volume of this gas was hardly 50 ccm.; it proved to be chiefly hydrogen, with a trace of hydrocarbons, arising from the small quantity of metallic magnesium present in the magnesium nitrid. After the hydrogen had been removed by explosion, an excess of oxygen was passed into the tube and the nitrogen removed in the usual manner by sparking over alkali. The presence of nitrogen here was undoubtedly due to the impossibility of perfectly exhausting all the air from so large a flask; the volume of nitrogen was about 10 ccm. There now remained but a minute bubble of gas, and on transferring this to a vacuum tube at very low pressure the spectrum of argon appeared. There was here, therefore, no trace of a new gas to be found.

It was not deemed worth while to investigate the ammonia, since I had already prepared nitrogen out of this and Lord Rayleigh had determined its density; he found this to be exactly the same as the density of nitrogen from different chemical sources. It remained, however, possible that the sought-for gas could combine with hydrogen, and that such a compound might possess an acid character; in this case it might have entered into combination with the magnesium. On account of the possibility that such a compound might be soluble, the magnesia was extracted with water, the solution evaporated and treated with sulfuric acid in a vacuum. A gas was evolved, but it proved to be exclusively carbon dioxid. We should have carried the treatment of the magnesium further had not the argon at last become sufficiently pure to subject it to the refrigerating action of liquid air; and it seemed to me there was more hope of finding the new substance in the argon from the atmosphere than in this residue of magnesia, which it would require much time and labor to work up.

Dr. Hampson, the inventor of a very simple and practical machine for the preparation of liquid air, which is based upon the same principle as that of Herr Linde, was so kind as to place large quantities of liquid air at my disposal. In order to become acquainted with the art of working with so unusual a material, I asked Dr. Hampson for a liter; with this Dr. Travers and I practiced and made different little experiments to prepare ourselves for the great experiment of liquefying argon.

It seemed to me a pity to boil away all the air without collecting the last residue; for, though it seemed improbable that the looked-for element could be here, yet it was, indeed, possible that a heavier gas might accompany the argon. This suspicion was confirmed. The residue from the liquid air consisted chiefly of oxygen and argon, and, after removing the oxygen and nitrogen, beside the spectrum of argon were two brilliant lines, one in the yellow, which was not identical with D_3 of helium, and one in the green. This gas was decidedly heavier than argon; its density was 22.5 instead of the 20 of argon. We had, therefore, discovered a new body, which was an element, for the ratio between the specific heats was 1.66. To this element we gave the name 'krypton.' Up to this time we have not followed further the study of this element; we have, however, collected and preserved many residues which are rich in krypton. It was, however, our first intention to examine the lightest part of the argon. In many, however, we remarked, in passing, that the wave-length of the green line of krypton is exceedingly close to that of the northern lights, being 5,570, while the latter is 5,571.

Our whole supply of argon was now liquefied in the following manner. The gasometer containing the argon was connected with a series of tubes in which the gas passed over respectively hot copper oxid, concentrated sulphuric acid and phosphorus pentoxid; it then passed by a two-way cock into a small flask, holding about 30 cubic centimeters, which was enclosed in a Dewar tube. By means of the other opening of the cock, the flask was connected with a mercury gasometer. By means of a U-shaped capillary and mercury trough, it was also possible, through a three-way cock, to collect the gas at will in glass tubes. About 50 cubic centimeters of liquid air were poured into the double-walled tube, and, by means of a Fleuss air pump kept constantly in action, the liquid air boiled at 10 to 15 millimeters pressure. The argon liquefied rapidly as soon as subjected to this low temperature, and in the course of half an hour it was completely condensed. Altogether there were about 25 cubic centimeters of a clear, limpid, colorless liquid, in which floated white flakes of a solid substance. By stopping the pump, the pressure over the liquid air was now increased, and the argon boiled quietly, the first portions of the gas being collected in the mercury gasometer. Changing now the three-way cock, the largest portion of the argon passed back into the iron gasometer; after nearly all the liquid had boiled away and only the solid substance was left in the flask, the last portions of the gas were collected separately. The solid substance remained persistently in the flask; it was slowly volatilized by means of a Töpler pump, which stood in connection with the apparatus.

We first directed our attention to the lighter fractions, for these had for us the greatest interest. The density of this gas was found to be 14.67; the ratio between the specific heats was as usual 1.66, and the spectrum showed, beside the well-known groupings of argon, a large number of red, orange and yellow lines of varying intensity. Evidently, we had before us a new element, which was contaminated with argon.

This gas was then liquefied in a similar apparatus to that first used, but constructed on a smaller scale; a portion, however, remained uncondensed. Even by raising the reservoir of the mercury gasometer until an overpressure of an atmosphere was reached, it was impossible to convert all the gas into a liquid, although the temperature of the boiling air was reduced as low as possible by rapid pumping. By repeated raising and lowering of the reservoir, we finally passed all the gas through the cooled space, in order to free it, as far as possible, from argon. The uncondensible gas was

collected by itself, and the remainder was evaporated into another gasometer.

You can well imagine how eager we were to know what the density of this purified gas would prove to be. It was immediately weighed. Our satisfaction can well be realized when we found that its density was 9.76. Since, however, its spectrum at low pressure still showed argon lines, though weak, we were compelled to admit that this number was certainly too high. It was impossible that this gas should not contain argon, since at the temperature used argon possessed a measurable vapor pressure.

We have, therefore, estimated that the density of the pure gas is 9.65. Here our work for the time was ended by the beginning of the summer holidays.

On our return we resumed the study of this gas, which we will hereafter designate by its name of 'neon.' Its spectrum was photographed by Mr. Baly, one of my assistants, by means of a spectrometer which we had constructed during the vacation. To our astonishment, the lines of helium were easily recognized. A comparison photograph showed this beyond all question. Hence the density of the gas was in all probability too low, owing to the presence of the helium. Since now the temperature used was insufficient to liquefy the neon, and since the argon had been removed as far as possible, we had to face the problem of how one could free neon from its accompanying impurities. A means was found in its solubility. It is well known that the solubility of those gases which do not react chemically with the solvent follows in general the same order as their condensibility. According to this helium should have a lesser solubility than neon, and neon than argon. The solubility of these gases in water is, however, too slight to be available for their separation. We have, therefore, used liquid oxygen as a solvent. This mixes with all three gases and boils at a temperature not far from the boiling point of argon. We, therefore, mixed the gas with sufficient oxygen to be almost wholly condensed at the temperature attained by boiling air at the lowest possible pressure. The uncondensed portion, about one fifth of the whole, was separated and collected as that richest in helium; the middle portion we considered as purified neon, while the remainder consisted of a mixture of argon and neon; naturally, all these portions contained oxygen in larger or smaller quantities.

After the removal of the oxygen, which was accomplished by passage over hot copper filings, we determined the density and refractivity of the middle portion. The density in two determinations was 10.04 and 10.19; the second figure was obtained after passing the electric spark through the gas mixed with oxygen in the presence of caustic potash and subsequent removal of the oxygen by phosphorus. The entire quantity weighed was only 30 cubic centimeters at a pressure of 250 millimeters. The weight was 0.0095 gram. I mention these figures in order to show with what an exceedingly small quantity of gas it is possible to carry out a very satisfactory density determination.

The refractivity of this portion with reference to the air as unity was 0.338. This portion still showed the spectra of argon and helium, and was, therefore, submitted to a second purification, in which the heavier part was more completely removed than the lighter. Even this purification, however, did not remove all the argon, but its quantity was decidedly diminished. The density was somewhat diminished, and helium was stronger in the spectrum. The entire amount of neon had become, by these operations, so divided up that it was not possible to carry out a further purification without preparing a greater quantity of crude neon. On this Dr. Travers and I are at present engaged.

In the meantime Mr. Baly has made exact measurements of the lines of the neon spectrum, at the same time eliminating all the lines which belong to argon and to helium by superposed plates. The values were compared with iron lines photographed upon the same plate, and the measurements were carried out by means of different pairs of these known lines. The most important lines are the following :

MOST IMPORTANT LINES OF THE NEW SPECTRUM.

Red.	Red.	Red.	Yellow (D_3).	Blue
6402	6267	6096	5853	4716*
6383	6218	6074	Green 5401	4722
6335	6164	6030	5341	4710
	6143		5331	4709
				4704

Up to the present we have had little time to study thoroughly the other companion of argon in the atmosphere. Dr. Travers and I have, however, worked upon it. The heavier fraction of the air contains three gases, one of which appears very perplexing. We have named it 'metargon.' This gas remains, mixed with excess of argon, after the evaporation of liquid air or argon. Up to this time we have not succeeded in obtaining it in a condition free from argon. Its peculiarity is that when it is mixed with oxygen and subjected to the influence of the electric spark in presence of caustic potash it shows constantly the 'Swan-spectrum' as of carbon monoxid. We have treated a mixture of carbon monoxid and argon in a similar way, and, after fifteen minutes' sparking, all the carbon had disappeared; in a Plücker tube no trace of the carbon spectrum could be recognized. I will, however, not yet venture to express an opinion as to the nature of this gas. It needs further investigation, and for this at present we have no time.

As regards krypton, which is distinguished by three brilliant lines, one in red, one in yellow and one in green, we are in much the same position. We have collected a considerable quantity of the impure gas, which shows the spectrum finely, although that of argon is also present. We hope that we shall soon be able to pursue this portion of our work further. We can merely note here that the specific gravity of the gas which shows this spectrum in such a marked way is not far different from that of argon.

The heaviest of these gases we have weighed, although in impure condition. Its density is 32.5. I need not call your attention to the fact that there is space for an element of the helium group between bromin and rubidium. Such an element should have an atomic weight of 81–83, which corresponds to a density of 40.5–41.5, under the very probable supposition that, like the other gases of this group, it is monatomic. The spectrum of this gas, which we have named 'xenon'—the stranger—has many lines; none of these are of marked intensity, and in this respect the spectrum resembles somewhat that of argon. It is also analogous to argon in another particular, that the spectrum undergoes a remarkable change when a Leyden jar is put into the circuit. As with argon, many new, blue and green lines appear, while other lines, mostly in the red, either disappear or lose much of their intensity. Further than this we have not proceeded in studying xenon; for our attention has been given chiefly to neon, as well as to a problem regarding argon.

We have repeatedly met the question: "Are the properties of argon not appreciably changed by the presence of this new gas?" In order to settle this question we have fractioned 25 cubic centimeters of liquid argon several times and have collected separately about 200 cubic centimeters of the lightest and as much of the heaviest fraction. This operation was repeated three

* The third figure in this number is probably a misprint (Tr.).

times. By this means we hoped to have removed the greatest part of the neon, krypton, metargon and xenon. Then we liquefied the argon a fourth time, and as it boiled away collected six samples, each after one-fifth of the whole quantity had evaporated. These samples were carefully purified and weighed. The density referred to O = 16 and the refractivity to air = 1 are as follows:

	Density.	Refractivity.
First fraction	19.65	0.962
Second "	19.95	0.969
Third "	19.95	.....
Fourth "	19.91*	.....
Fifth "	19.97	0.968
Sixth "	19.95	0.966

The first fraction possesses, as appears from the table, a lower density and also a lower refractivity. The other fractions vary very little from each other. Since these determinations were made by using only 30 cubic centimeters, we have weighed 160 cubic centimeters of the fifth and sixth fractions. The first determined density of the fifth fraction was 19.935, but at a pressure of 5 millimeters the spectrum of nitrogen was easily recognizable in a Plücker tube. After the gas had been again purified by sparking, until all the nitrogen had been removed, the density was 19.957. In two experiments the fourth fraction of gas gave 19.952 and 19.961. We must then accept the true density of argon as not far from 19.96. Independently Lord Rayleigh and I found the density of argon to be 19.94; so it is clear that the impurities of neon and the heavier gases have little influence. The somewhat greater density of pure argon arises from the fact that the neon, which is the chief impurity present, has been removed; the influence of the other gases cannot be recognized, owing to the insignificant quantities present. In fact, in 15 liters of argon we found no appreciable trace of xenon; it can be prepared only out of large quantities of liquid air.

I must take this opportunity of thanking you most sincerely for the honor you have done me in inviting me to deliver this address. It has been said by some scientist that the greatest joy of life lies in discovering something which is new. There is, however, another joy almost equally great, that of making known the results of an investigation to one's fellow scientists. This joy, my friends, you have given me to an extreme degree, and for this I express to you my warmest thanks.

* Contained nitrogen.

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*A CASE OF CONVERGENCE.**

In 1859 Girard (Proc. Acad. Nat. Sc. Phila., p. 62) described a small blind fish, *Typhlichthys subterraneus*, from Bowling Green, Ky. This species has since been found to be abundant in the subterranean waters east of the Mississippi and south of the Ohio.

In 1889 Garman (Bull. Mus. Comp. Zool. XVII., No. 6) gave an account of a blind fish from some caves in Missouri. Mr. Garman says: "Compared with specimens from Kentucky and Tennessee, they agree so exactly as to raise the question whether the species was not originated in one of the localities and thence distributed to the others. * * * There is no doubt that the representatives of *Typhlichthys subterraneus* in the various caves were derived from a single common ancestral species. The doubts concern only the probability of the existence of three or more lines of development in as many different locations, start-from the same species and leading to such practical identity of result."

Ably arguing the case from the data on hand Garman came to the conclusion "that these blind fishes originated in a particular locality, and have been and are being dis-

* Contributions from the Zoological Department of the Indiana University, No. 27.

tributed among the caves throughout the valley" (of the Mississippi).

Two of the specimens from Missouri served Kohl (Rudimentäre Wirbelthieraugen, 1892) for his account of the eyes of North American blind fishes. At my request Mr. Garman sent me two of the Missouri specimens. He urged me at the same time to make a more extensive comparison between them and the Mammoth cave specimens. A comparison of the eyes of specimens from the two localities not only proved that they represent distinct species, but that they are of separate origin. An announcement of the species without further description was published (Proc. Ind. Acad. Sci. for 1897, p. 231, 1898). The species was "named *rosæ* for the rediscoverer of the California *Typhlogobius*, a pioneer in the study of Biology among women, Mrs. Rosa Smith Eigenmann." In the spring of 1897 I visited various caves in Missouri to secure additional material of what was recognized as in many ways the most interesting member of the North American fauna. No specimens were secured, but a liberal number of bottles of alcohol and formalin were scattered over the country. During the fall of 1898, through a grant from the Elizabeth Thompson Science Fund and through the courtesy of the officers of the Monon, the L. E. and St. L. and the Frisco R. R. lines I was enabled to visit the cave region of Missouri again. This time I visited nine caves and secured eight specimens. I have since received an additional number from a correspondent. From information gathered it would seem that this species (or similar ones) has a wide distribution in the subterranean waters of the southern half of Missouri and northern Arkansas, probably also the eastern part of Kansas.

On the surface the specimens very closely resemble *Typhlichthys subterraneus* from Mammoth cave, differing slightly in the proportion and in the pectoral and caudal fins. These fins are longer in *rosæ*. It is, however, quite evident from a study of their eyes that we have to deal here with a case of convergence of two very distinct forms. They have converged because of the similarity of their environment and especially owing to the absence of those elements in their environment that lead to external protective adaptations. The details of the structure of the eyes of all the members of the Amblyopsidæ will be published shortly, and I need call attention here only to the structures that warrant the conclusion that the cis- and trans-Mississippi forms of blind fishes without ventral fins are of distinct origin. The blind fish *Amblyopsis* may be left out of consideration, since it is the only member of the family that possesses ventral fins. Otherwise, it would be difficult to distinguish specimens of similar size of this species from either *subterraneus* or *rosæ*.

The eye of *T. subterraneus* is surrounded by a very thin layer of tissue representing

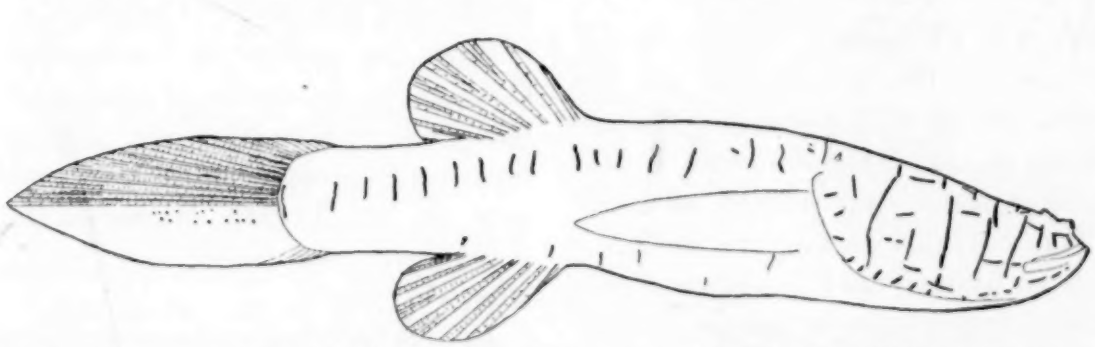

FIG. 1. Side view of Troghlichtys showing the extent and distribution of the tactile organs.

the sclera and choroid. The two layers are not separable. In this respect it approaches the condition in the epigean-eyed member of the family, *Chologaster*. For other reasons that need not be given here it is quite certain that *Typhlichthys* is the

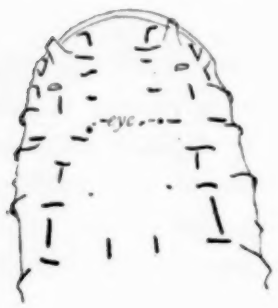

Fig. 2.

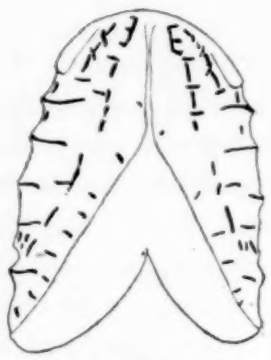

Fig. 3.

Fig. 2. Dorsal view of the head, with distribution of tactile organs and location of eye.

Fig. 3. Ventral view of the head.

descendant of a *Chologaster*. The intensity of coloration and the structure of the eye are the chief points of difference. The eye of *rosæ* is but about 1-3 the diameter of that of *subterraneus*, measuring .06 mm. or thereabout. It is the most degenerate, as distinguished from undeveloped, vertebrate eye. The point of importance in the present instance is the presence of comparatively enormous scleral cartilages.* These have not degenerated in proportion to the degeneration of the eye and in some cases are several times as long as the eye, projecting far beyond it or are puckered to make their disproportionate size fit the vanishing eye. This species is unquestionably descended from a species with well-developed scleral cartilages, for it is not conceivable that the sclera as found in *Chologaster* could, by any freak or chance, give rise during degeneration to scleral cartilages, and if it did they would not develop several sizes too large for the eye. At present no known epigean species of the Amblyopsidæ possesses scleral cartilages. The ancestry of *rosæ* is hence unknown. *Amblyopsis* possesses scleral cartilages and the eye of *rosæ* passed through a condition similar to that possessed by *Amblyopsis*, but the latter species has ventral fins and is hence ruled out as a possible ancestor of *rosæ*. The epigean ancestry of *Amblyopsis* is also unknown. The ancestry of *Typhlichthys* being quite distinct from that of *rosæ*, the latter species may be referred to a new generic name *Troglichthys*.

Judging from the degree of degeneration of the eye *Troglichthys* has lived in caves and done without the use of its eyes longer than any other known vertebrate. (*Ipnopes* being a deep-sea form is not considered.) More than this, *rosæ* is probably the oldest resident in the region it inhabits.

Since the specimens kindly sent by Mr. Garman, in the course of examination have been reduced to sections, the specimens now in my possession, together with a few sent to the British Museum, all having come from the same cave, may be considered typical.

In addition to the acknowledgments made before I wish also to thank the officers of the Louisville and Nashville R. R. for transportation to Mammoth Cave. I must especially express my appreciation of the assistance rendered me by Mr. William McDoel, General Manager of the Monon, in enabling me to make explorations in the numerous caves of the Lost River region along his line and to visit caves at greater distances. Mr. H. C. Ganter, the manager of the Mammoth Cave Hotel, not only granted me leave to collect in the cave, but did everything possible to make my trip to this cave successful.

Carl H. Eigenmann.

University of Indiana.

* Kohl mistook the nature of these structures, as he did of every other connected with these eyes, except the lens and ganglionic cells.

*REPRODUCTIVE OR GENETIC SELECTION.**

1. THE object of this memoir is twofold: first, to develop the theory of reproductive or genetic selection† on the assumption that fertility and fecundity may be heritable characters; and, secondly, to demonstrate from two concrete examples that fertility and fecundity actually are inherited.

The problem of whether fertility is or is not inherited is one of very far reaching consequences. It stands on an entirely different footing to the question of inheritance of other characters. That any other organ or character is inherited, provided that inheritance is not stronger for one value of the organ or character than another, is perfectly consistent with the organic stability of a community of individuals. That fertility should be inherited is not consistent with the stability of such a community, unless there is a differential death-rate, more intense for the offspring of the fertile, *i. e.*, unless natural selection or other factor of evolution holds reproductive selection in check. The inheritance of fertility and the correlation of fertility with other characters are principles momentous in their results for our conceptions of evolution; they mark a continual tendency in a race to progress in a definite direction, unless equilibrium be maintained by any other equipollent factors, exhibited in the form of a differential death-rate on the most fertile. Such a differential death-rate probably exists in wild life, at any rate until the environment changes and the equilibrium between natural and reproductive selection is upset. How far it exists in civilized communities of mankind is another and more difficult problem, which I have partially dealt with elsewhere.* At any rate it becomes necessary for the biologist either to affirm or deny the two principles stated above. If he affirms them, then he must look upon all races as tending to progress in definite directions—not necessarily one, but possibly several different directions, according to the characters with which fertility may be correlated—the moment natural selection is suspended; the organism carries in itself, in virtue of the laws of inheritance and the correlation of its characters, a tendency to progressive change. If on the other hand, the biologist denies these principles, then he must be prepared to meet the weight of evidence in favor of the inheritance of fertility and fecundity contained in Parts II and III of the present memoir.

2. The theory discussed in Part I opens with the proof that if fertility be a function of any physical characters which are themselves inherited according to the law of ancestral heredity, then it must itself be inherited according to that law. As fertility would certainly appear to be associated with physique, we have thus an *à priori* argument in favor of its inheritance.

3. In the next place the influence of 'record' making on apparent fertility is considered. The mother with more offspring has a greater chance than one with fewer of getting into the record which extends over several generations, and, further, if every possible entry be taken from the

* Mathematical Contributions to the Theory of Evolution. Part I, Theoretical: By Karl Pearson. Part II, On the Inheritance of Fertility in Man: By Karl Pearson and Alice Lee. Part III, On the Inheritance of Fecundity in Thoroughbred Race-horses: By Karl Pearson, with the assistance of Leslie Bramley-Moore. Abstracts read before the Royal Society, December 8, 1898.

† I have retained the term 'reproductive' selection here, although objection has been raised to it, because it has been used in the earlier memoirs of this series. Mr. Galton has kindly provided me with 'genetic' and 'prefertal' selection. The term is used to describe the selection of predominant types owing to the different grades of reproductivity being inherited, and without the influence of a differential death-rate.

* Essay on Reproductive Selection in 'The Chances of Death and other Studies in Evolution,' Vol. 1, p. 63.

record, she is again weighted with her fertility. Thus a record is not a true account of the fertility of successive generations. The fertility of mothers is always found to be more and their variability less than the fertility and variability of daughters. Accordingly from the apparent fertility and variability of the record the actual values in each generation must be deduced. The difficulties and the theory of this investigation are developed at some length, and methods determined by which it can be ascertained whether a secular change in fertility is actually taking place. The results obtained are extended to fecundity.

4. In the case of thoroughbred horses their number is so few and in-breeding so great, owing to the fashion in sires and stocks, that we have to deal with a large array of offspring of the same sire. It is easy accordingly to obtain 50,000 to 150,000 pairs of a given relationship, *e. g.*, half-sisters, and we rapidly get numbers too large for forming correlation tables in the usual manner. Accordingly methods are developed for finding correlation coefficients from the means of 'arrays.' These methods are of considerable importance, for they enable us to ascertain the correlation between a latent character in one sex and a patent character in another, or between characters latent in two individuals. Thus it is shown that the correlation between the brood-mare's fecundity latent in two related stallions can be deduced from the correlation between the mean fecundities of their two arrays of daughters. In this way a numerical estimate can be formed of the inheritance of latent characters.

5. The brood-mare is for many causes, detailed at length in the paper, a highly artificial product, and accordingly the record gives a considerable percentage of fictitious fecundities. The effect of a mixture of correlated and uncorrelated material on correlation and and variation is next investigated, and it is shown that the former is more seriously affected than the latter. Hence results based on variation are more likely to be trustworthy than those which use correlation. Incidently the problem of the mixture of heterogeneous materials uncorrelated in themselves is investigated, and it is shown that a correlation will result in the mixture. This *spurious* correlation is of some importance for the question of mixtures of classes in fertility problems, but it is also significant of the general danger of heterogeneity in bio-statistical investigations, and further indicative of the possibility of creating correlation between two characters by breeding between small heterogeneous groups in which this correlation is zero. This illustration suffices to indicate how correlation between characters does not necessarily indicate a causal relationship.

6. Part II of the memoir deals with the inheritance of fertility in man. It is first shown by large numbers that fertility is undoubtedly inherited from mother to daughter, but that if we include all types of marriages the inheritance is largely screened by other factors. An attempt is made to remove one by one these factors, and the more stringently this is done the more nearly the regression of daughter on mother moves up towards the value required by the law of ancestral heredity. If we could take only marriages in which both daughter and mother were married during the whole of their fecund period there is little doubt that we should find inheritance according to the law of ancestral heredity. The sparseness of homogeneous material hinders, however, such an investigation.

The inheritance of fertility from father to son is then considered; this is really rather an inheritance of sterility or tendency to sterility, for the full fecundity of a man is not usually exhibited in mono-

gamic union. It is rather a problem of whether his fecundity lasts as long as his wife's. We find definite inheritance of this sterile tendency from father to son, although for the reason just given it falls below that indicated by the law of ancestral heredity.

Lastly, the inheritance of fertility in the woman through the male line is dealt with, and it is shown that a woman's fertility is as highly correlated with that of her paternal as with that of her maternal grandmother. In other words the latent character, fertility in the woman, is transmitted through the male line, and with an intensity which approximates to that required by the law of ancestral heredity. Incidentally the problem of 'heiresses' is dealt with. It is shown that in the case of women that are chiefly 'heiresses' there is at once a considerable drop in the correlation between their fertility and that of their mothers, while there is a small drop only in their average fertility. In other words, an 'heiress' is not to be looked upon as coming in general from a sterile stock, but as having a mother whose fertility has a fictitious value, *i. e.*, the apparent fertility of the record is not the potential fertility, the inherited character, in the mother. In other words, 'heiresses' are not as a rule due to sterile mothers, but in the bulk are due to such causes as late marriages, restraint, incompatibility of husband and wife, absence of sons or death of other children, etc.

7. Part III of the memoir contains the results of a somewhat laborious investigation into the fecundity of brood-mares, which has been a number of years in progress. Had better material been available for the inheritance of fecundity we would gladly have adopted it in preferance to dealing with such an intricate subject as the breeding of race-horses. Unfortunately, the absence of place and means hindered any experimental investigation on our part into the inheritance of fecundity in some simpler type of life. Such investigation ought certainly to be made by a trained biologist, with the knowledge and the laboratory at his disposal.

After discussing at length the steps taken by us to measure and tabulate the fecundity of brood-mares, we deduce the following conclusions:

(i.) Fecundity in the brood-mare is inherited from dam to mare.

(ii.) It is also inherited from grand-dam to mare through the dam.

In both cases the intensity is much less than would be indicated by the law of ancestral heredity, but the divergence is not such that it could not be accounted for by a percentage of fictitious values such as the peculiar conditions of horse-breeding warrant us in considering probable.

(iii.) The latent quality, fecundity in the brood-mare, is inherited through the sire; this is shown not only by the correlation between half-sisters, but by actual determination of the correlation between the latent character in the sire and the patent character in the daughter.

(iv.) The latent quality, fecundity in the brood-mare, is inherited by the stallion from his sire. This is shown not only by the fecundity correlation between a sire's daughters and his half-sisters, but also by a direct determination of the correlation between the latent quality in the stallion and in his sire.

In both these cases of latent qualities the law of inheritance approaches much more closely to that required by the Galtonian rule. This is probably due to the fact that the determination of the correlation is thrown back on the calculation of the means and variabilities of arrays, and not on the direct calculation of the correlation between fecundities, a large percentage of which are probably fictitious (see § 5).

8. Parts II and III accordingly force us

to the conclusion that fertility is inherited in man and fecundity in the horse, and, therefore, probably that both these characters are inherited in all types of life. It would, indeed, be difficult to explain by evolution the great variety of values these characters take in allied species if this were not true. That they are inherited according to the Galtonian rule seems to us very probable, but not demonstrated to certainty. It is a reasonable hypothesis until more data are forthcoming.

The memoir concludes with a discussion of the meaning of reproductive selection for the problem of evolution and with sixteen correlation tables, giving the dressed material on which our conclusions are based.

THE NEW YORK MEETING OF THE AMERICAN PHYSIOLOGICAL SOCIETY.

The American Physiological Society held its eleventh annual meeting in New York, December 28, 29 and 30, 1898. The first day's sessions were held at the physiological laboratories of the College of Physicians and Surgeons, the medical school of Columbia University. The forenoon session of the second day consisted of a joint meeting of the Society and the American Psychological Association at Schermerhorn Hall, Columbia University; in the afternoon the members attended at the same place the joint meeting of the Affiliated Scientific Societies. The sessions of the third day were held at the physiological laboratories of the University and Bellevue Hospital Medical College. In attendance and the number of papers presented the meeting was the most successful yet held, and demonstrated the fact that a large amount of research in physiology is being carried on in the laboratories of this country.

The forenoon session of Wednesday, the first day, was devoted largely to the presentation of the chemico-physiological communications. Professor J. J. Abel (Johns Hopkins) discussed 'Epinephrin, the active constituent of the suprarenal capsule, and its compounds.' He has succeeded in isolating from the suprarenal capsule a specific chemical body which produces the peculiar physiological effects heretofore recognized with extracts of the capsule. He has carefully determined its chemical properties and classes it with the alkaloids with the formula $C_{17}H_{15}NO_4$. Drs. J. B. Wallace and W. Mogk, through Professor G. C. Huber, presented a report of an experimental study upon the 'Action of suprarenal extract on the mammalian heart,' performed in the laboratory of Professor A. R. Cushny (Michigan University). The extract was found to stimulate the vagus center, thus inhibiting the heart, to stimulate the heart muscle directly and to cause a constriction of the systemic arterioles. Dr. Walter Jones (Johns Hopkins) and Professor R. H. Chittenden (Yale) reported the results of independent investigations of the melanines, the black pigment occurring in hair and in the skin of the negro. The former obtained the pigment from black horsehair by treatment with hydrochloric acid. Fusing with caustic potash gave a sulphur melaninic free, which when oxidized in an alkaline medium is easily decomposed into carbonic acid and ammonia, but in an acid medium yields certain more complex bodies. The facts presented by Professor Chittenden tended to show that melanines or melanine-like pigments can be prepared artificially from antialbumid and hemipeptone by long heating with 10% sulphuric acid at 100°C. The exact composition of the melanine thus formed depends largely upon the extent of the hydrolytic cleavage of the proteid. By invitation, Dr. Beattie Nesbitt (Toronto) read a paper on 'The presence of cholin and neurin in the intestinal canal during its complete

obstruction.' His experiments lead to the belief that complete occlusion of the small intestine at its lower end will give rise to the occurrence of cholin, neurin, and, perhaps, other bases, provided the food taken contains a considerable quantity of lecithin. Cholin is only slightly, neurin powerfully, toxic. Professor W. T. Porter (Harvard) reported further 'Experiments on the mammalian heart.' Experiments on the isolated ventricles supplied with blood through the coronary arteries and cut in various directions show that the synchronism of the ventricles is not dependent on nerve-cells, is probably maintained through muscular and not through nervous connections, and is not a function of the auricles, but is managed by the ventricles themselves. Dr. Reid Hunt (Johns Hopkins) gave an account of his extended researches on 'Direct and reflex acceleration of the mammalian heart.' The accelerator nerves exert a tonic action upon the heart. The accelerator centers show greater resistance to the action of drugs, etc., than do the cardio-inhibitory or the vaso-motor centers. Continued stimulation of the accelerator nerves causes genuine fatigue in the heart, and, if long continued, even death. Reflex acceleration is due usually, if not always, to an inhibition of the tonic activity of the vagi.

Dr. S. J. Meltzer (New York) opened the afternoon session with a paper on 'The causes of the orderly progress of the peristaltic movements in the œsophagus.' The author's experiments tend to harmonize the statement of Mosso, who found that division of the œsophagus does not prevent the progress of the peristalsis below the cut and concluded that the peristalsis is of central origin, and the statement of Wild, who found peristalsis to cease at the cut and inferred that its progress is of peripheral origin. The author proved that the difference in the results was due to the fact that Wild experimented on animals under deep anæsthesia, while Mosso's animals were only lightly anæsthetized.

The greater part of the afternoon session was devoted to demonstrations and the exhibition of new apparatus. Professor G. Carl Huber (Michigan University) demonstrated methylene-blue preparations of sensory nerve-endings in tendon — Golgi's tendon corpuscles. Professor W. T. Porter (Harvard) demonstrated the coordination of the ventricles in the mammalian heart. The following exhibitions of apparatus were made: A convenient form of non-polarizable electrode, by Professor W. H. Howell (Johns Hopkins); new laboratory apparatus, by Dr. E. W. Scripture (Yale); an improved form of Ellis's piston recorder, by Professor W. P. Lombard (Michigan University); a simple etherizing bottle, by Dr. C. C. Stewart (Columbia); a simple oncometer, by Professor F. S. Lee (Columbia); a new respiration apparatus, by Professor F. S. Lee.

The papers presented at the joint session of the Society and the American Psychological Association on the forenoon of Thursday, the second day, were calculated to interest both physiologists and psychologists. After an address of welcome by Professor Münsterberg, the President of the Psychological Association, Professor Chittenden, the President of the Physiological Society, was called to the chair and the prepared program was entered upon. Professor J. McK. Cattell (Columbia) gave a descriptive exhibition of instruments for the study of movement and fatigue. Professor F. S. Lee (Columbia) presented the results of an extended series of experiments upon 'The nature of muscle fatigue.' The course of fatigue in the muscles of the frog, the turtle and the cat shows certain differences, the common element being a decrease of lifting power. The chief cause of muscle fatigue appears to be poisoning by fatigue substances. Fatigue is a protective phenomenon, pre-

venting the oncoming of exhaustion. Professor G. Carl Huber (Michigan) reported his 'Observations on the innervation of the intracranial vessels.' In the pia mater and the cranial dura mater of the dog, cat and rabbit two kinds of nerves were found, sensory and vasomotor, the former being medullated, the latter non-medullated. The latter were found to terminate in the muscular wall of the arteries. Professor C. F. Hodge (Clark University) reported upon a research undertaken with Mr. H. H. Goddard to test the possible amœboid movements of cortical nerve-cells. The brains of rested and fatigued animals were compared. All the experiments in which definite results were obtained confirmed Demoor's results, showing a contracted and varicose condition of the dendrites, and, moreover, extend our knowledge to include effects of normal fatigue. The experiments were fully controlled, the control specimens showing dendrites and contact granules uniformly expanded. Dr. G. W. Fitz (Harvard) exhibited a new chronoscope, in which the time is measured by the fall of water within a graduated glass tube. A valve at the lower end of the tube is opened and closed by electro-magnets connected with the keys of the reaction apparatus. By invitation Professor O. N. Rood (Columbia) exhibited his flicker photometer. Professor Münsterberg discussed 'The physiological basis of mental life.' Professor G. T. W. Patrick (Iowa) discussed 'The confusion of tastes and odors.' Dr. E. W. Scripture gave an exhibition of methods of demonstrating the physiology and psychology of color.

At the joint meeting of the Affiliated Societies, on Thursday afternoon, in the discussion upon 'Advances in methods of teaching,' Professor W. T. Porter read a paper upon 'The teaching of physiology in medical schools.'

At the first session on Friday, the third day, Professor Chittenden exhibited a convenient form of sphygmograph. Professor Graham Lusk (University-Bellevue), reported for Mr. W. H. Parker on 'The maximum production of hippuric acid in rabbits.' If benzoic acid be fed to rabbits in quantity just sufficient to unite with the glycocoll formed in the animal, the nitrogen that is excreted in the hippuric acid is in a fixed ratio of about 1 : 20 to the total nitrogen of the urine. This indicates that about 5 % of the nitrogen of proteid may be eliminated in the form of glycocoll. The latter is probably a cleavage product of proteid to this extent. Professor Chittenden presented the results of 'A chemico-physiological study of certain derivatives of the proteids.' The paper dealt especially with the results obtained in a careful study of the physiological action of a large number of specific cleavage products of proteids when introduced directly into the circulation. Antipeptone, antialbumid, antialbumoses, protogelatose, deterogelatose, pure gelatine peptone and so-called hemipeptone were among the products studied. The influence on the blood-pressure, blood-coagulation, immunity, lymph flow, urinary secretion, etc., were all carefully studied and results of interest were obtained. Professor G. N. Stewart (Western Reserve) presented the results of numerous experiments on 'The molecular concentration and electrical conductivity of certain animal liquids with special reference to blood.' Professer H. P. Bowditch (Harvard) read for Dr. J. K. Mitchell a paper on 'The influence of massage upon the number of blood globules in the circulating blood.' In health massage increases the number of red corpuscles and to some extent their hæmoglobin value. In anæmia there is a very constant and large increase in the number of red corpuscles after massage. Anæmia may be due to a lack of activity or availability in the corpuscles. Dr. P. A. Levene (New York)

gave the results of his investigations on the tissues of the higher animals as to their power of combining iodide intramolecularly. After administering potassium iodine to fowls and analyzing during ten weeks the eggs and later the tissues, he concludes that the power of combining iodine in the organism belongs only to certain keratins, such as that of the hair, to certain proteids, such as that of the thyroid gland, and to certain fats. Professor Wesley Mills (McGill) spoke of the 'Correlation of the functional and anatomical development of the cerebrum.' Professor Chittenden reported progress in the investigation of the properties of the edible and poisonous fungi which was undertaken by a committee of the Society appointed for this purpose two years ago.

At the afternoon session on Friday, Professor G. Carl Huber presented 'A note on the sensory nerve-endings in the extrinsic eye-muscles of the rabbit—atypical motor endings of Retzius. The author has repeatedly observed these nerve-endings and gave reasons for believing them to be sensory and not motor. In the absence of Professor L. B. Mendel (Yale), a paper by him, on 'The paths of absorption from the peritoneal cavity,' was read by the President. In a number of experiments upon absorption it was observed that the solution employed appeared in the urine considerably earlier than in the lymph. The author is inclined to the blood-vessel theory of absorption. Drs. P. A. Levene and I. Levin (New York), made a preliminary communication on the absorption of the proteids. Because of their easy identification iodoproteids were studied, being injected into a loop of the intestine and later sought for in the lymph. The results were negative and in so far tend to confirm the accepted theory of absorption by the blood system. By invitation Professor E. O. Jordan (Chicago) gave the results of experiments upon 'The production of fluorescent pigment by bacteria.' The presence of both phosphorus and sulphur is essential to the formation of this pigment. The relative fluorescigenic values of a variety of chemical bodies were studied. The presence of acid and diffuse daylight are unfavorable to pigment production. Professor C. F. Hodge described for Mr. H. H. Goddard a new brain microtome which is constructed on two new principles: the knife, which is stationary, is level in order to carry liquid in which the section floats, and the brain is moved against the knife. By invitation Dr. L. J. J. Muskens (New York) exhibited an instrument for measuring muscular tonicity in man.

In addition to the above papers, a number of others were read by title. The following were elected members of the Society: Professor W. O. Atwater (Wesleyan), Professor S. P. Budgett (Washington), Dr. A. M. Cleghorn (Harvard), Dr. W. J. Gies (Columbia), Professor W. S. Hall (Northwestern), Dr. Walter Jones (Johns Hopkins), Professor E. O. Jordan (Chicago), Dr. A. P. Mathews (Tufts), Professor B. Moore (Yale), Dr. C. C. Stewart (Columbia) and Professor F. F. Westbrook (Minnesota). There were elected as members of the Council for 1898–'99: Professors Chittenden, Howell, Lee, Lombard and Porter. The details of the establishment of the *American Journal of Physiology*, under the auspices of the Society, were presented and made a part of the records. The *Journal*, now in its second volume, has abundantly justified its existence.

FREDERIC S. LEE,
Secretary.

SCIENTIFIC BOOKS.

The Discharge of Electricity through Gases. By J. J. THOMSON. New York, Charles Scribner's Sons. 1898. Small 8vo. Pp. 203. Price, $1.00.

This volume contains, in modified form, the four lectures delivered by Professor Thomson

on the occasion of the sesqui-centennial celebration at Princeton, in October, 1896. As the subject is one that is rapidly developing, the author has added the results of numerous investigations that have been published since that time; so that the present volume gives an excellent presentation of the subject as it now stands.

Although the electrical discharge in gases has been investigated in its various phases ever since the study of electricity itself began, it is only in the last five or six years that our knowledge of the subject has begun to take systematic and satisfactory form. Careful observations had been made by hundreds of physicists, and the scientific literature abounded with descriptions of phenomena of great interest and undoubted scientific importance. But our knowledge of the subject consisted of a mass of *isolated* facts; no satisfactory underlying theory had been found by which these facts could be correlated. The development of such a theory is largely due to Professor Thomson, and I know of no place where it is so satisfactorily treated as in the volume before us. The book is not one requiring the preparation of a specialist in order that it may be understood; the greater part can be read with pleasure and profit by one having only an elementary knowledge of electrical science. On the other hand, I should not speak of the book as containing merely a 'popular' account of the subject, especially if the word 'popular' is to be regarded as having the same significance as inaccurate. Writers of popular science are, unfortunately, only too prone to look upon the two words as synonymous. Professor Thomson, however, possesses the rare power of writing upon a difficult subject with scientific accuracy, and at the same time in such a way as to be intelligible to the lay reader.

The contents of the book are arranged under three chief sub-divisions, namely: the Discharge of Electricity through Gases; Photo-electric Effects, and Cathode Rays. This classification is not wholly satisfactory, for each sub-division contains a great deal more than is indicated by its title. But the numerous sub-headings, to which reference is made in the table of contents, make it a matter of no great difficulty to find any special topic sought. A fairly complete series of references to original sources constitutes a feature that cannot be too highly commended.

To one unfamiliar with the subject the first twenty pages will probably prove the most difficult portion of the book. The topics there discussed are the various methods by which a gas may be electrified: for example, by chemical processes, by electrolysis, and by the splashing of liquids. The essential peculiarities of the conducting power of gases are first brought into prominence in the account of the effect of Röntgen rays in giving to a gas the power of conducting electricity. Only a few weeks after the discovery of the X-rays it was found that an electrified body rapidly lost its charge when exposed to these rays. This property of the new rays was independently and almost simultaneously discovered by at least five different physicists, Professor Thomson being one of these, and has since been the subject of numerous investigations. The subject is one in which experimental errors are especially difficult to avoid, and a great deal of confusion naturally existed at first regarding the laws of the phenomenon and the conditions of its occurrence. Practically all of the more reliable experiments are now seen to support the view that the discharge of an electrified body by the Röntgen rays is due to the fact that the gas surrounding the body is made a conductor by the action of these rays. It is thought that the condition developed in the gas is somewhat similar to that in an electrolyte, *i. e.*, *ions* are formed, some carrying positive charges and others negative charges. A charged body placed in the 'ionized' gas would attract one kind of ions and repel the other. Upon coming into contact with the charged body the ions are supposed to give up their charges and cease to exist as ions. The gas is thus rendered capable of conducting electricity in much the same manner that an electrolyte conducts. But an essential difference exists between the two cases, due to the fact that the ionized condition of the gas is only *temporary;* in less than a second after the Röntgen rays have ceased the ions have recombined and the gas is as good an insulator as ever.

Conducting power may be imparted to a gas

not only by the action of Röntgen rays, but also by extreme heat and by the chemical changes that occur in flames. These cases are considered in the second part of the book. Here also the effects are readily explained upon the theory that the conduction is electrolytic. In fact, it is the development of this theory in its application to the various types of gaseous conduction that constitutes the most characteristic feature of the book. An accidental error in one of the formulas on page 37, whose consequences appear also in some of the equations on the two succeeding pages, may cause annoyance to one reading hurriedly. A serious misprint occurs on page 42, where 10^{-11} appears several times as 10^{11}.

An interesting account is given, in the second division of the book, of the curious effect of light in causing the discharge of *negative* electricity. This effect is produced chiefly by the shorter light waves, and preeminently by the invisible ultra-violet rays of the spectrum. It depends not only upon the gas surrounding the charged body, but also upon the nature of the charged surface. The electro-positive metals, such as zinc, sodium and rubidium, show the effect best. The fact that phosphorescent substances are especially sensitive to this effect, though as yet unexplained, is of undoubted significance.

The third section of the book, devoted to cathode rays, contains an excellent account of the recent experiments on this subject. Such an account is of especial value because of the extraordinary rapidity with which our knowledge of these rays has advanced. It is interesting to note that the study of cathode rays, as well as the study of the other phenomena of vacuum tubes, has received a fresh impetus since the discovery of the X rays; if this study leads to important discoveries, as it now seems almost certain to do, I think that these must be regarded as indirect results of the discovery of Röntgen.

It is quite out of the question to call attention in this brief review to the many interesting and important subjects that are discussed throughout the book. The discussion is often brief and lacking in the detail that would be useful to one making a specialty of the subject. But the book is written by one whose own investigations have contributed largely to the development of each of the topics considered, and who is now engaged in further research along the same lines. This fact gives to the treatment a charm impossible of attainment otherwise, and adds to the book a suggestiveness and inspiration which must appeal to all who read it. ERNEST MERRITT.

Text-book of Physiology. Edited by E. A. SCHÄFER, LL.D., F.R.S. Vol. I. New York, The Macmillan Co.

This new text-book of physiology follows out the idea of combining under one editorship the writings of different men who treat of the special subjects in physiology with which they have had personal and intimate experience. In the face of the great and ever widening scope of the science of physiology, no work of general authority can be written in any other manner to-day.

In illustration of this we find in this volume, which covers merely the chemical side of physiology, reference to fully six thousand original articles. The book is highly creditable to the eleven English physiologists who have contributed to it, and it strengthens the general opinion that in physiology the English are second only to the Germans. The Germans, however, have no such comprehensive and thorough reference text-book as this. The work is hardly one for medical students, but is intended for the teacher, for the advanced investigator, or for reference in the medical library.

The article on the chemistry of the digestive processes is ably written by B. Moore. He attacks the theory of the cleavage of proteid into two molecules, the 'hemipeptone' and 'antipeptone,' for example, and claims that the existence of the 'hemi-' bodies has never been proved. He suggests that trypsin may act on a single molecule of albumose which may yield a greater or lesser quantity of amido acids according to the albumose used, and that the residue of the molecule which cannot be further attacked by trypsin is antipeptone. In the discussion of the composition of the fæces, Moore, in common with almost every text-book of physiology, makes the mistake of giving too

important a place to the residues of the food stuffs, omitting to state that the fæces consists rather of the residues of the excretions which pour into the intestinal tract.

In the article on the 'Chemistry of Respiration,' written by M. S. Pembrey, the statement is made that in Voit's respiration apparatus the moisture expired by the animal may sometimes be deposited in the conducting tubes before reaching the vessel where it is caught and weighed. With proper manipulation, however, this does not take place, and such a statement should not be too lightly made when it tends to invalidate a large quantity of carefully executed work.

The articles by Schäfer himself are characterized by breadth of thought and a balanced judgment which often causes him to make clear a middle ground between opposing theories. In his article on the 'Mechanism of the Secretion of Milk' he is inclined to doubt that milk is the product of the bodily disintigration of the lactic cells, but that, as in formation of saliva, granules are extruded from the cells, which granules dissolve to form the milk.

J. H. Langley has written a very complete monograph on the subject of the Salivary Glands, which includes his own important work.

The other authors are W. D. Halliburton, Arthur Gramgee, E. Weymouth Reid, E. H. Starling, J. S. Edkins, D. Noël Paton and F. Gowland Hopkins, all familiar names to the working physiologist.

The edition published here is identical in make up to that published in England and is everything that could be desired.

Graham Lusk.

University and Bellevue Hospital Medical College, New York City.

SCIENTIFIC YEARBOOKS.

The second volume of *L'Année biologique*, edited by Professor Yves Delage and published at Paris by Schleicher frères, follows the excellent lines laid down in the first volume and represents the best work accomplished hitherto by the various yearbooks recently established in France. The subjects are treated under twenty chapters, each beginning with a critical survey, usually written by MM. Delage and Poirault, followed by a bibliography and abstracts of most of the papers. The digests are often detailed, *e. g.*, the notice of Cope's Primary Factors of Organic Evolution extends to 14 pp., and the account of the contents of a book or paper is usually clearly separated from such criticism as is given. The subjects treated and the number of titles given are as follows:

The cell, 171.
Sexual products and fertilization, 8.
Parthenogenesis, 6.
Asexual reproduction, 12.
Ontogenesis, 52.
Monstrosities, 71.
Regeneration, 46.
Grafting, 10.
Sex and sexual characters, 28.
Polymorphism, metamorphism and the alternation of generations, 29.
Latent characters, *vacat.*
Correlation, 26.
Death, immortality, the germ plasm, 10.
Morphology and general physiology, 275.
Heredity, 57.
Variation, 78.
The origin of species, 110.
Geographic distribution, 50.
The nervous system and mental functions, 203.
General theories, 48.

It is unfortunate that this recently-issued volume refers to 1896, instead of 1897, but the preparation of these 808 large pages represents a great amount of labor for which all students of the biological sciences should be grateful.

M. Binet's *L'Année psychologique* (Schleicher, Paris) combines the publication of special papers with a review of the progress of psychology in 1897. MM. Binet and Vaschide contribute separately and in conjunction no less than twenty-two researches to the present volume, and there are in addition two papers by M. Bourdon and one by M. Leclère. The papers, which deserve special review, are chiefly concerned with the individual differences of school children and contain many interesting suggestions, though, as a rule, the work is not carried far enough to secure definite results. The bibliography, compiled in the first instance by Drs. Farrand and Warren for *The Psychological Review*, contains 2,465 titles, and

about 90 of these papers are abstracted and reviewed, chiefly by M. Binet.

L'Année philosophique, of which M. Pillon is the editor and Alcan the publisher, in the issue for 1897 reaches its eighth volume. It contains articles by M. Renouvier on the idea of God, by M. Dauriæ on the philosophy of Paul Janet, and by the editor on Bayle and the altruism of Epicurus. The editor also offers a review of French philosophical publications extending to 140 pages. There is no bibliography.

MESSRS. LEMCKE AND BUECHNER, New York, are the American agents of a newly established bibliography of French periodicals, edited by M. Jordell. The example set in America was last year followed in Germany, and we are now glad to welcome a similar enterprise in France. In this first issue 146 periodicals are included, a subject index and an authors' index being provided. Scientific journals are not, as a rule, considered, but it is exactly articles that appear in the general journals that are most likely to escape the attention of scientific men, and the usefulness to them of such an index is evident. It should be accessible in all the larger libraries.

GENERAL.

IT is stated that progress has been made with the preparation, for publication, of the extensive scientific material collected during the voyage of the *Fram*, and that there is a likelihood that the first volume of memoirs will be issued during the coming summer or autumn. The collection will be in quarto form, and the separate memoirs will be the work of a number of specialists in the subjects treated, each being paged separately. The total number will probably be about twenty, forming from three to five volumes. The memoirs will be published at the expense of the Nansen Fund for the advancement of science.

A QUARTO memoir upon *Polypterus* is being projected at Columbia University as the result of the Senff Expedition to the Nile. Specialists in the nerves, muscles, blood vessels and visceral anatomy will divide the work, which is designed to be of the most exhaustive character. Mr. Harrington is taking charge of the distribution of the Senff collection to specialists in all parts of the country and in Europe, with the understanding that the results will be published by the New York Academy of Science, and thus constitute a special and uniform series, which can finally be issued in compact form.

PROFESSOR TITCHENER, of Cornell University, is prepariug for publication early in the fall 'A Laboratory Manual of Experimental Psychology,' which will be published by The Macmillan Company. The work will be in two volumes and will detail an elementary course of laboratory work. The first volume will deal with qualitative analysis, the second with the exact measurement of mental processes. Each volume will be published in a student's and a teacher's edition, the former giving instructions as regards the conduct of experiments, control of introspection, etc., and the latter furnishing references, cognate questions and exercises and standard results.

BOOKS RECEIVED.

In the Australian Bush and the Coast of the Coral Sea. RICHARD SEMON. London and New York, The Macmillan Company. 1899. Pp. xii + 552. $6.50.

The Principles of Bacteriology. FERDINAND HUEPPE. Translated by DR. E. O. JORDAN. Chicago, The Open Court Publishing Co. 1899. Pp. viii + 467. $1.75.

The Dawn of Reason or Mental Traits in the Lower Animals. JAMES WEIR. New York and London, The Macmillan Company. 1899. Pp. xiii + 234. $1.25.

A Brief Introduction to Modern Philosophy. ARTHUR KENYON ROGERS. New York and London, The Macmillan Company. 1899. Pp. viii + 360.

The Story of the Cotton Plant. F. WILKINSON. New York, D. Appleton & Co. 1899. Pp. 191.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *Journal of Physical Chemistry*, January. 'Pressure temperature Diagrams for Binary Systems,' by Wilder D. Bancroft.' 'The Dissociative Power of Solvents,' by Louis Kahlenberg and Azariah T. Lincoln: a study of electrical conductivity of a number of salts in non-aqueous solutions, more fully noticed in 'Notes on Inorganic Chemistry.' 'Boiling-point curves,' by E. F. Thayer: the boiling point curves for mixtures of alcohol and chloroform,

acetone and alcohol, and chloroform and acetone; it is found that a mixture of benzene and alcohol with 33.5% alcohol distils unchanged at 66.7° under 737 mm. pressure; chloroform and alcohol with 7% alcohol distils without change at 58.5° under 732.5 mm.; and chloroform and acetone with 19% acetone distils unchanged at 63.4° under 737.1 mm.; the boiling points of all mixtures of alcohol and acetone lie between the boiling points of pure alcohol and pure acetone. 'Reversible Reactions,' by John Waddell: a mathematical paper on the conversion of ammonium cyanate into urea, criticising a recent paper by Walker and Hambly in the *Journal of the Chemical Society*.

'Scientific *vs.* Poetic Study of Education' is the title of the opening article, by Charles DeGarmo, in the March *Educational Review* (Holt & Co.). Other articles in the number will be: 'The High School Principal,' by John Tetlow; 'A School-Garden in Thuringia' (Illustrated), by Herman T. Lukens; 'Educational Value of Bird-Study,' by Frank M. Chapman; 'Vacation Schools,' by Charles Mulford Robinson; 'Report of the Chicago Educational Commission'; 'Fraudulent Diplomas and State Supervision,' by Henry Wade Rogers; 'School Supervision in New York State,' by Walter S. Allerton.

The Geographical Association of Great Britain, at its annual meeting, on January 11th, adopted the *Journal of School Geograyhy*, edited by Professor R. E. Dodge, New York, as its medium for the publication of information of service to teachers of geography.

SOCIETIES AND ACADEMIES.

WASHINGTON BOTANICAL CLUB.

The third regular meeting was held February 1, 1899, at the residence of Mr. J. G. Smith.

Mr. C. L. Shear exhibited and discussed a parasitic fungus found on *Abiescon color* and *Picea Engelmannii* in the subalpine regions of the Rocky Mountains. This fungus attacks the lower branches of the younger trees, first forming a brown, felt-like layer over the branch and gradually spreading until frequently a foot or more of the branch is enveloped and killed. The fungus is closely related to *Herpotricha nigra* Hartig, which is frequent on conifers in similar regions in Europe. Though not agreeing exactly with the description, it seems to be what was first described by Professor C. H. Peck in Hayden's Report as *Sphæria Coulteri*.

Under the title 'Plant Formations of Western Lake Erie' a brief account was given, by Mr. A. J. Pieters, of the swamp formation and of the aquatic plant formation of the Put-in-Bay region. The extensive swamps on the main land at East Harbor are made up of various plant associations in each of which there is a dominant species, while in the other, dominant species of the formation are nearly or quite excluded, though many smaller forms are present everywhere if the depth of water does not prevent. The Scirpus Americanus Association is characteristic of the beach either when this is subject to heavy wave action or on dry sand bars; it also occurs in lagoons behind the bars. Throughout the swamp the different associations succeed each other, their arrangement being sometimes dependent upon depth of water, while at other times no relation could be detected between depth of water or character of bottom and the presence of the dominant species.

The aquatic plant formation was classified provisionally into associations which were grouped under two headings: *a*, free swimming forms; *b*, attached species. Three associations were recognized under the first:

1. The Plankton. This includes the free swimming, microscopic forms in deep water.

2. The Utricularia Association. Rootless, fine-leaved phanerograms and masses of algæ floating free beneath the surface in quiet water.

3. The Lemna Association. Small phanerograms floating free on the surface of the water.

Five associations of attached forms were recognized:

4. The Cladophora Association. Algæ attached to stones on the bottom or to the submerged stems of plants.

5. The Desmid Association. Mostly unicellular algæ lightly attached to fine-leaved phanerogams in quiet water.

6. The Chara Association. Low-growing plants covering the bottoms of shallow bays or pools.

7. The Potamogeton Association. Plants reaching nearly or quite to the surface, with long internodes and variously shaped leaves rooting in the mud and growing in water from one to ten feet deep.

8. The Nelumbo Association. Plants rooting the bottom and having floating or both floating and aerial leaves.

Two or more of these associations often occupy portions of the same area, but the plants of each association differ in their habits and usually remain distinct from those of other associations; not infrequently new combinations arise, the species of any association not always remaining where it is commonly found. This arrangement, however, expresses in the main the grouping of the plants as found in the waters and swamps of western Lake Erie.

Mr. C. L. Pollard exhibited specimens of two proposed new species of *Viola*. One of these is from Vermont and is related to *V. blanda* Willd.; it is conspicuous, however, for its large flowers, robust habit and unusually-developed rootstock. The other plant comes from southern California and belongs to the Chrysanthæ; it has very glaucous foliage and flowers half the size of *V. Douglasii*, its nearest congener.

The Club devoted the remainder of the evening to a general discussion on certain questions related to ecology.

CHARLES LOUIS POLLARD,
Secretary.

TORREY BOTANICAL CLUB—ANNUAL MEETING, JANUARY 10.

NINETEEN new members were elected, and the previous board of officers, including, as President, Hon. Addison Brown; Treasurer, Maturin L. Delafield, Jr.; Recording Secretary, Edward S. Burgess; Editor, Lucien M. Underwood. Annual reports were presented, that of the Treasurer indicating a cash balance in hand.

The Recording Secretary, Professor Burgess, reported an average attendance of 39 at the 15 meetings held during the year, one death, a present active membership of 193, corresponding membership 140, honorary membership 3, total 336. The 27 scientific papers presented include 20 authors, among these non-resident being Dr. Radlkofer, of Vienna, and Casimir De Candolle. About 20 new species have been described. Among the papers 6 were on taxonomic and other subjects relating to cryptogams, 2 on the nucleus, 2 were accompanied by lantern-views, and 2 by exhibits of photographs; 6 were followed by symposia for which general discussions had been prepared. Brief reports of collections and of botanical progress numbered 42. Two collations had marked the year's history, one tendered to the Club on March 8th, by the Teachers' College, and one tendered by the Club to visiting botanists, especially to members of the Society of Plant Morphology, at Columbia Univers ty, December 29th.

The editor, Professor Underwood, reported the regular monthly issue of the *Bulletin*, including 640 pages and 29 plates, with a balance to the credit of the *Bulletin*. Slight changes in the *Bulletin* include the introduction of author and subject head-lines, the arrangement of matter to begin each new article with a new page, and the use of improved plates. By discontinuing book reviews and miscellaneous notes more space has been gained for articles of research. The number of pages is itself 50 in excess of those of the preceding year. New numbers of the *Memoirs* are in preparation. A series of complete volumes of the *Bulletin* has been filed ready for sale, and surplus numbers inventoried and separated to supply the demand for single copies. An endowment fund is greatly desired, by which secure provision may be made for prompt publication and superior illustration of American botanical researches.

The report of the Field Committee, through its Chairman, Mr. W. A. Bastedo, enumerated 36 field meetings, all held in cooperation with the Brooklyn Institute; 3 of these were 3-day excursions in cooperation with the Philadelphia botanists, viz., at Decoration Day to Point Pleasant, N. J., at the Fourth of July to Stroudsburg, Pa., and at Labor Day to Whiting's, N. J.

In behalf of the Committee on Local Phanerogamic Flora, Dr. Britton referred to the work hitherto accomplished, as represented in Dr. Torrey's catalogue of 1819, and the two pre-

liminary catalogues published already by this Club, by Mr. W. H. Leggett in 1875–6, and by Britton, Sterns and Poggenburg in 1888. Local catalogues within our range include those of Suffolk County, L. I., by Miller and Young; of Staten Island, by Dr. Hollick and others; of New Jersey, by Dr. Britton, Dr. Rusby and others; of Long Island, by Dr. Jelliffe. Special interest attaches to Mr. Bicknell's work on the Westchester County Flora. It was desired that the new committee continue and combine the researches contributory to the ultimate publication of a comprehensive Flora of the Metropolitan District, adding such details as possible as to ecological and quantitative characters.

In behalf of the Committee on Local Cryptogamic Flora, Mrs. E. G. Britton reported that a catalogue of the Mosses of the Botanical Garden at Bronx Park is about to be published in its annual report.

Dr. Britton read a letter which he had received that morning from Mr. A. A. Heller, from Ponce, Porto Rico, announcing his arrival in health. He observed many interesting plants, as Crotons, in the vicinity of Ponce. Mr. Henshaw is about to join him, for further collections, particularly of living material for the Botanical Garden.

Dr. Britton also reported the formal opening of work on January 3d, toward the great range of Horticultural Houses for the Botanica Garden, which it is hoped may be ready for installation in October.

Dr. Rusby reported his possession of a manuscript catalogue of the economic plants of Cuba and Porto Rico, giving the botanic names, uses and common names, in about 8 volumes of 200 pages each. This is the work of our corresponding member, Professor De la Maza, of the University of Havana, who, although but a young man, has formed a large collection of plants there, comparing them carefully with the Charles Wright collection of Cuban plants, which is also in the University of Havana.

Dr. Britton also referred to the tour Dr. Fairchild is now taking along the Chilian coast in the hope of establishing some plant exchanges.

Edward S. Burgess,
Secretary.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

The 495th meeting of the Society was held at 8 p. m., at the Cosmos Club, on February 4th. An informal communication was first presented by Dr. L. A. Bauer, read by Mr. J. F. Hayford, entitled 'Is the Principal Source of the Secular Variation of the Earth's Magnetism Within or Without the Earth's Crust?' The first regular paper was by Mr. J. H. Gore, on the 'Beginnings of Geodesy in the United States.' The second paper was by Mr. E. D. Preston, on 'Geodetic Operations in the United States.' Both of these papers will, probably, appear in full in Science within a short time.

E. D. Preston,
Secretary.

ALABAMA INDUSTRIAL AND SCIENTIFIC SOCIETY.

The annual meeting of the Alabama Industrial and Scientific Society was held in the city of Birmingham, Ala., on Wednesday afternoon, February 1, 1899, with about twenty members in attendance. In the absence of the President, Professor M. C. Wilson, caused by a delayed train, the meeting was called to order by ex-President F. M. Jackson. After the reading of the minutes of the last meeting, the action of the Society at that meeting, recommending amendments to the State mining laws for the purpose of securing *monthly* returns of the production of the various minerals of the State, was reconsidered, and it was decided to recommend that the laws be amended so as to include only *yearly* returns of the production of coal, coke, iron ores, pig iron, limestone, dolomite, building stones, clays, bauxite, etc. The present law requires returns only from the producers of coal and coke.

Upon recommendation of the Council, three new members were elected and a number of papers accepted.

Under the head of new business, a resolution was adopted favoring the passage of United States Senate Resolution No. 205, 'To provide for a Division of Mines and Mining in the United States Geological Survey,' and the Secretary was instructed to communicate this resolution to the Alabama Senators and Congressmen, and also to bring the matter to the attention of the Commercial Club of Birmingham, with request that like action be taken by that body.

Upon the arrival of President Wilson, he read his address as retiring President, giving a general *résumé* of the work of the Society during the past year, and making some suggestions about its future work. The importance was also urged of establishing in the city of Birmingham a School of Natural Sciences, in which every youth in the limits of the city might have the opportunity of acquiring some scientific training, and especially in those branches of science which bear upon the manufacture of iron. The establishment of such a school would cause similar schools to spring up in the smaller towns and would be followed by industrial growth.

Papers were then read as follows: 'The Brown Ores at Leeds, in Jefferson County,' by J. W. Castleman, of the Sloss Iron and Steel Co. In this paper an account was given of the large deposits of brown ore recently developed by the Sloss company. 'On Trichina spiralis,' by Dr. John Y. Graham, of the State University. This paper, based upon original investigations by Dr. Graham, was illustrated by charts and by specimens under the miscroscope. 'On Roads and Road Making,' by Colonel Horace Harding. 'British Columbia and its Mineral Resources,' by Wm. M. Brewer. 'A Section through Red Mountain,' by A. W. Haskell.

The election of officers for the ensuing term was then taken up, with the following result: President, J. H. Fitts, of Tuscaloosa; Vice-Presidents, J. M. Garvin, of Rock Run, and J. H. McCune, of Woodward; Treasurer, Henry McCalley, of the University of Alabama; Secretary, Eugene A. Smith, University of Alabama. The Society then adjourned, to meet again on May 3d, next. After the adjournment the members of the Society and their invited guests partook of a banquet at the Morris Hotel.

EUGENE A. SMITH,
Secretary.

DISCUSSION AND CORRESPONDENCE.

ETHERION.

TO THE EDITOR OF SCIENCE: In a recent number of SCIENCE attention was called to what appeared to be an unreasonable attitude on the part of the editors of *Nature* towards Mr. Charles F. Brush's paper on Etherion, an attitude, namely, which simply refused to accept Mr. Brush's results until they were demonstrated by the spectroscope. A recent criticism by M. Smoluchowski de Smolan in *Nature* for January 5th is, on the other hand, entirely reasonable, being, as it is, a fair criticism of Mr. Brush's work. The question whether heat conductivity can demonstrate the existence of an unknown thing, and the question whether Mr. Brush really found a gas which had one hundred times the thermal conductivity of hydrogen *at the same pressure*, are very different. It is this latter question which is raised by M. de Smolan. It seems probable, indeed, that the anomalous thermal conductivity found by Mr. Brush may have been due to his not having rigorously excluded water vapor, thus making his pressure determinations uncertain. We may soon expect an answer to this point from Mr. Brush himself.

W. S. FRANKLIN.

NOTES ON INORGANIC CHEMISTRY.

AN extended research has been made by E. Hintz on the effect of varying quantities of the rare earths on the luminosity of the mantels for the Welsbach burners. The results are published in the *Zeitschrift für analytische Chemie.* Comparing the oxids of thorium and cerium alone and mixed in varying proportions, and, using for comparison the number of liters of gas consumed per hour per Hefner light unit, it appears that the consumption for pure thoria is 50 and for pure ceria 61. With traces of ceria in thoria the consumption decreases, 0.1% ceria giving 6.7; 0.2%, 3.1, and 0.5%, 2.1. On the other hand, thoria added to ceria has much less effect, 30% thoria requiring 48; 60%, 31, and 80%, 12. The minimum consumption, that is, the greatest light efficiency, is reached with a mixture of 99% thoria and 1% ceria, with which the consumption of gas is only 1.4 liters per hour per Hefner unit. Some decrease of efficiency is noticed after several hundred hours' use. As regards the addition of other oxids to this 'normal' thoria-ceria mixture (99:1) 1% of neodymia, lanthana, yttria or zirconia has no effect; nor does 2% of the first three. Two per cent. of zirconia, however, diminishes

slightly the efficiency. Larger proportions of these oxids are prejudicial, especially those of neodymia and yttria.

Commercial calcium carbid has, as is well known, a reddish brown color. Moissan has lately studied this color and finds that it is due to the presence of iron, even traces of which give it a decided tint. He finds, however, that the pure calcium carbid crystals are colorless and transparent.

Apropos of the disputed occurrence of copper as a normal constituent of plants, Professor G. B. Frankforter, of the University of Minnesota, describes, in the last *Chemical News*, a very interesting occurrence of metallic copper disseminated in the pores of an oak tree in Minneapolis. The tree had died, and, on cutting it up, the presence of copper was so noticeable as to attract attention. Microscopic examination showed that only the outer annual rings contained an appreciable quantity of the metal, which was in the form of fine flakes, some of them 1.5 mm. in diameter. The copper appeared to be very pure. It seemed as if the tree had begun to absorb the metal only in the last few years, and that this had occasioned its death. The origin of the copper was uncertain, though the soil is known to contain native copper. The fact that the copper was in the native state would raise the question as to whether this is the usual form in which it occurs in plants. Another question might be raised as to whether plants take up any of the copper which is so largely used in fungicides, and as to whether this would eventually destroy a tree on which it was used.

Up to within a comparatively short time the physical chemistry of solutions has been almost confined to those in which the solvent is water. Attention is now being turned to other solutions, and very interesting questions arise as to the applicability of the theory of electrolytic dissociation and other theories which have been worked out only with aqueous solutions. We have already noticed in these columns the work of E. C. Franklin, of the University of Kansas, on liquid ammonia as a solvent. In the January number of the *Journal of Physical Chemistry*, L. Kahlenberg and A. T. Lincoln, of the University of Wisconsin, detail a number of experiments with different non-aqueous solvents as to electrical conductivity. The solvents used were methyl and ethyl alcohol, acetone, ethyl aceto-acetate, benzaldehyde, and nitro-benzene. The substances dissolved were the chlorids of iron, antimony, bismuth, arsenic, tin and phosphorus. The molecular weights were also determined by freezing point depression with nitrobenzene as a solvent. The results obtained are not uniform enough, nor large enough in number, to be used for any generalization, but the following significant sentences occur at the close of the paper: "The general outlook at present appears to be that, in order to harmonize the molecular-weight determinations in many non-aqueous solutions with the relatively high electrical conductivity of the latter, the assumption that combination between solvent and dissolved substance takes place will have to be made. *Can it be true that, after its glorious success in explaining the properties of aqueous solutions of acids, bases and salts, the dissociation theory will need the help of its old rival, the hydrate theory (perhaps in a somewhat modified form), to explain the facts in the case of non-aqueous solutions?*" The authors call attention to the ideas of Werner regarding the existence of hydrated metal ions in solution, a theory which partakes of the nature of the two rival theories of solution. While Werner's theory may be in many respects unsatisfactory, it deserves to be better known among chemists, and may foreshadow something of the direction chemical thought will take, in the development out of the present valence theories.

J. L. H.

CURRENT NOTES ON METEOROLOGY.

WATERSPOUTS OFF THE COAST OF NEW SOUTH WALES.

An incident quite unique in the history of waterspout observation occurred on May 16, 1898, off Eden, New South Wales. On this day fourteen complete waterspouts, and six others, more or less incomplete, occurred in the space of five hours. It so happened that a mining engineer, Mr. D. R. Crichton, was engaged in making certain observations with a theodolite in Eden at the time when the waterspouts began to form off-shore. Mr. Crichton made the most of his very exceptional opportunity;

watched the spouts carefully through the telescope of his theodolite, and obtained some definite measurements as to the height of the largest spout. According to his calculations the height above the sea of the top of the inverted cone was 5,014 ft. The cones at the top and bottom of the spout were about 100 ft. in diameter, and the length of each cone from its base to the points at which the sides of the spout appeared parallel was about 250 ft. Mr. H. C. Russell, the Government Astronomer of New South Wales, has published an admirable, illustrated account of this remarkable series of waterspouts, together with a record of previous waterspouts, and some observations as to the conditions under which these phenomena occur. (Journ. Roy. Soc., N.S.W., Vol. XXXII., 1898.)

ANNUAL REPORT OF THE CHIEF OF THE WEATHER BUREAU.

THE *Annual Report* of Professor Willis L. Moore, Chief of the Weather Bureau, emphasizes once again the wide scope of the work of the Bureau and the value of this work to the public at large. The extension of the meteorological service to include observations at various stations in the West Indies, Mexico and Colombia has already been referred to in these Notes. The observations made during the International Cloud Year are under discussion and will soon be published. The total number of forecasts distributed during the year, exclusive of those published in the daily papers, was, approximately, 23,531,500. Sixty-four per cent. of this distribution was by logotype cards, sent through the mail or carried by messengers; 23% by maps and bulletins; 10% through cooperation of railroad, telegraph and telephone lines; 3% by telegraph and telephone lines at the expense of the Bureau. Weather maps to the number of 5,239,800 were distributed. A section of the Climate and Crop Service has been established in Alaska. A meteorological chart of the Great Lakes has been issued monthly during the season of navigation.

METEOROLOGICAL CHART OF THE GREAT LAKES.

THE *Meteorological Chart of the Great Lakes*, dated January 4th, contains a summary, for the year 1898, of the storms on the Lakes, the number of disasters and of lives lost, the values of the vessels lost, and the causes of the disasters. Thirty-nine vessels were totally lost, all as the result of gales. Of the partial losses (104), 22 were due to fog and 82 to gales. The number of lives lost was 96. The relative frequency of fog over the Lakes during the season of navigation (April 1st to December 15th) is shown by five different styles of shading.

NOTES.

A NOTABLE work on the physiological effects of high altitudes has recently been issued. It is an English translation—entitled 'Life of Man on the High Alps' (London, 1898)—of a book originally written in Italian by Professor Angelo Mosso, of Turin. According to *Nature* (January 26th) this "is the first attempt that has been made to present the various complex physiological phenomena which man exhibits at high altitudes in such a form as to be easily understood by those who are not trained physiologists."

IN his Presidential address before the Royal Meteorological Society on January 18th, Mr. F. C. Bayard stated that in the British Isles only two shillings and sixpence per square mile is voted by the government for the support of meteorology. This amounts to one-third of a farthing per head.

R. DEC. WARD.
HARVARD UNIVERSITY.

CURRENT NOTES ON ANTHROPOLOGY.

MEGALITHIC MONUMENTS.

AT the last meeting of the German Anthropological Society, Professor Virchow delivered a long and elaborate address on the 'megalithic monuments' of Europe. He rejected all theories so far advanced as to their builders, and left it as a question for the future to settle.

Mr. W. C. Borlase, probably the best authority on the subject, is the author of a work in three volumes on 'The Dolmens of Ireland.' His descriptions are excellent, but in his search for their constructors he loses himself in the maze of Irish legendary lore, and falls into the common error of supposing that because the same stories are told and the same superstitious practices obtain concerning these monuments in Ireland, Spain, France and Germany there must have been relations and borrowing. This

mistake in his reasoning is well pointed out by Mr. Alfred Nutt in a review of the work in the *Folklore Journal* (March, 1898). Identity of psychology, he justly insists, is the true explanation.

THE MEANING OF PRIMITIVE ORNAMENT.

On few questions in ethnology is there wider diversity of opinion than about the intention of primitive decoration. Does it arise from a mere love of imitation, without further idea? Is it mystical and symbolic, in some way an expression of the religious sentiments? Is it due to utilitarian aims, a sort of graphic method? Or is it the expression of the sense of the beautiful, genuinely artistic?

Each of these opinions has its defenders. In the *Internat. Archiv für Ethnographie* (1898, Heft II.) Van Panhuys caustically reviews the question, and concludes with the pertinent inquiries: Cannot the same decorative designs arise among peoples who have had no relations with each other? Why must the meaning or origin of these designs be everywhere the same? These are, indeed, pointed and pertinent interrogatories and hint at the true solution of the inquiry.

GENEALOGY AS A BRANCH OF ANTHROPOLOGY.

In his opening address before the last meeting of the German Anthropological Society, Professor Johannes Ranke emphasized the value of genealogical investigation as an aid to anthropology. By it we learn the facts of heredity, the influence of kinship, the consequences of intermarriage of relations, the permanence or variation in family traits, psychical and physiological peculiarities and their transmission, the tendency to reversion of types, the effect on the children of marriages at different ages, and many more points of very great interest.

For genealogy, however, to be thus promoted to the dignity of a science it is necessary that those who cultivate it should be willing to tell the truth about the family trees in which they are interested; and in America, notably in Philadelphia, they are yet a long way off from taking this position.

D. G. Brinton.

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SCIENTIFIC NOTES AND NEWS.

The Berlin Academy of Sciences has conferred its Helmholtz medal on Professor Virchow. It was established on Helmholtz's birthday in 1892, and has since been conferred on Du Bois-Reymond, Weierstrass and Lord Kelvin.

Dr. Roux, of the Pasteur Institute, has been elected a member of the Agricultural Section of the Paris Academy of Sciences, in the room of the late M. Aimé Girard. M. Risler, Director of the Agricultural Institute, received fourteen votes, and M. Maquenne, professor of the applications of physics to agriculture in the Paris Museum, received two votes, as compared with forty-one for M. Roux.

At the last meeting of the British Institution of Electrical Engineers, Lord Kelvin was elected an honorary member. Lord Kelvin is the oldest surviving past President of the Institution, having held the office of President in 1874.

The Hungarian Society of Natural History has elected M. de Freycinet a corresponding member, and has translated into Hungarian his essay, 'Sur la philosophie des sciences.' This translation is distributed among the members of the Society, which, we are glad to learn, number 8,000.

Invitations have been issued for the celebration, at Cambridge, of the jubilee of Professor Sir George Gabriel Stokes, to the plans for which we recently called attention. Sir George Stokes was elected Lucasian professor of mathematics on October 23, 1849. The ceremonies will take place on June 1st and 2nd of the present year.

M. Picard, Commissioner-General of the Paris Exposition of 1900, has been elected an honorary member of the British Institution of Civil Engineers.

Professor E. B. Wilson, of Columbia University, after visiting the Naples Zoological Station, has gone to Egypt, and is endeavoring to follow up the work of Messrs. Hunt and Harrington in pursuit of the life-history of *Polypterus*.

The Berlin Academy of Sciences, with the assistance of the Heckmann-Wentzel foundation, has undertaken to explore Lake Nyassa and the

surrounding regions, with a view to studying the fauna and flora. Dr. Fülleborn will act as zoologist and Dr. Götze as botanist of the expedition.

Nature states that Dr. Don Francisco P. Moreno, Director of the La Plata Museum, and Commissioner of the Argentine Republic in the boundary delimitation with Chile, has arrived in London from Buenos Ayres.

PROFESSOR F. KÜSTNER, Director of the Observatory at Bonn, has been appointed Director of the Hamburg Observatory, Professor G. Rümker having resigned this position on account of ill health.

MR. J. H. HOLLAND has been appointed Director of the Botanical Gardens in Calabar.

THE annual meeting of the Malacological Society, London, was held on February 9th. The Presidential Address was delivered by Lieut.-Colonel H. H. Godwin-Austen, F.R.S.

LECTURES on geology will be given at the American Museum of Natural History during March as follows: March 4th, Professor James F. Kemp, on 'The Newer Gold Regions of the West,' with especial reference to the Cripple Creek country of Colorado, Mercur, Utah, and the Yukon basin; March 11th, Mr. Walter H, Weed, of the United States Geological Survey, on 'The Gold and Silver Mines of Montana;' March 18th, Dr. Hienrich Ries, of Cornell University, on 'Clay and Its Uses;' March 25th, Dr. David T. Day, on 'The Geology of Petroleum.'

THE Vienna Medical Club has voted the sum of three hundred gold crowns for the foundation of a prize in memory of Dr. Hermann Franz Müller, whose recent death from the plague will be remembered.

WE learn from *Nature* that at its annual meeting, on January 10th, the Russian Academy of Sciences awarded its Helmersen premium to A. Mickwitz for his work, 'Die Brachiopoden. Gattung *Obolus*, Eichwald'; the Lomonosoff premium to N. I. Andrusoff for his work, 'The fossil and the living *Dreissenidae* of Eurasia'; to E. Burinsky, for his improvements in photography; and to P. I. Brounow, for his works in meteorology. The large Tolstoi medal was awarded to L. Besser and K. Ballod, for their researches into the natality and mortality of the populations of European Russia, the Baltic provinces, and different countries of Europe, including Great Britain; and the small medal to P. G. Matsokin, for a MS. work on the half-breeds of Transbaikalia.

MR. E. A. MARTEL has been awarded the grand medal of the French 'Société de Topographie.

THE second award of the Weber-Parkes prize and medals of the Royal College of Physicians of London (awarded triennially to the writer of the best essay upon some subject connected with the ætiology, prevention, pathology or treatment of tuberculosis, especially with reference to pulmonary consumption in man) will be made in 1900. The value of the prize is 150 guineas and a silver medal. A similar medal, distinguished as the second medal, will be awarded to the essayist who comes next in order of merit.

WE learn, with regret, of the death, from pneumonia, of Professor Wilbur Wilson Thoburn, professor of biomechanics, at Leland Stanford Jr. University.

WE regret also to record the following deaths: Dr. G. Wolffhügel, professor of hygiene in the University at Göttingen; Dr. Rupert Böck, professor of mechanics in the Technical Institute of Vienna, and Dr. Lench, assistant in the Observatory at Zurich.

IN the British House of Commons on February 8th Mr. Akers Douglas (Kent, St. Augustine's) said: "All the new buildings for South Kensington Museum on the east side of the Exhibition-road will be devoted to the art collections. The existing science building on the east side of the road will be the only portion which will continue to be used for science purposes. The new science buildings will be erected on the west side of the road. The plans have been prepared by the architect in communication with the officers of the art and science branches, and meet with the approval of the Lord President and his department. It is proposed to commence the new buildings in front of the South Kensington Museum within the next few weeks."

Sometime since we called attention to the appointment of a commission in France to consider the question of colonial botanical gardens and agricultural experiment stations. This commission has now recommended that a station be established in each of the French colonies and a central station for the distribution of seeds and plants. A decree has been issued organizing such a station at Vincennes and M. Jean Dybowski has been appointed its director.

Plans have been made for the erection of a State Meteorological Station on the summit of Schneekope, one of the Riesengebirge, Silesia, which is 1,605 meters in height. A scientific observer will be stationed in the observatory.

It is feared that the instruments of the Manila Observatory have been injured by the recent battles. The Observatory is well equipped for meteorological and seismological observations, and its publications have been of much scientific value.

The Brooklyn Institute will establish in its museum a department in which natural history and technology will be exhibited in a manner that will interest and instruct children. There are such museums in foreign cities, but not, it is said, elsewhere in America.

Mr. Andrew Carnegie, in addition to offering $250,000 for a free library in Washington, and $100,000 for a free library at Atlanta, has also offered to provide libraries for Richmond, Va., and Bellefonte, Pa. Mr. Carnegie has already given more than $8,000,000 for the establishment of free libraries.

Open competitive merit examinations will be held March 1st to 7th, 1899, in various cities throughout New York State for the positions mentioned below. Exact dates will be fixed later for the various cities, and candidates having applications on file will be given ample notice of the time and place of examination most convenient to their place of residence. Intending competitors must file applications in the office of the Commission before February 28th. Assistant Commissioner of Agriculture, Third Division.—Applicants must be residents of this division, which includes the counties of Columbia, Delaware, Dutchess, Greene, Orange, Putnam, Rockland, Sullivan, Ulster and part of Westchester. Salary, $1,500 per annum. The examination will relate entirely to the duties of the position, the experience of the candidate, his knowledge of agriculture and its interests in the division and his familiarity with the laws relating to the Department and its work. Assistant at the Agricultural Experiment Station, Jamaica, N. Y.—Candidates must have a practical knowledge of farm and garden work, and should have some training in the fundamentals of botany and entomology; they must also have the knowledge of the care of a forcing house, spraying and the supervision of other experiments conducted by such a station. Salary, $600 per annum. The examination will relate wholly to the duties of the position and the knowledge and experience required for their performance. Time allowed, seven hours. Library Assistant, State Library.—Salaries, $30 to $50 per month. The examination will cover cataloguing, classification, indexing, library economy, indexing and handwriting.

The Department of State has received from the German embassy at Washington, under date of January 21, 1899, notice of the international veterinary congress to be held at Baden on August 9–14, 1899. The subjects to be discussed include prophylactic measures to prevent the spread of cattle diseases by the export of animals, treatment of tuberculosis in domestic animals, use of flesh and milk of animals affected by tuberculosis and requirements for inspection of meat, cure of foot and mouth disease and diseases of swine, dissemination of veterinary instruction, preparation of a uniform anatomical nomenclature in veterinary medicine and cure of rabies. The members of the congress shall consist of delegates from foreign countries and the German Empire, representatives of veterinary schools who are designated to the committee, delegates of veterinary and agricultural societies, representatives of state and communal offices of public health and public hygienic institutes, and veterinarians who record their names and pay 12 Marks.

At a meeting held January 20th by the Belgian Society of Electricians (M. Emile Closset, President) it was decided to open an exposition of electrical appliances applicable to domestic

uses. The exposition will be held next May, in the new post and telegraph office, Place de la Monnaie, Brussels.

THE Twenty-eighth Congress of the German Surgical Society will be held in the Langenbeckhaus, Berlin, from April 5th to 8th, under the presidency of Professor Eugen Hahn.

A SUIT is being brought by the Treasurer of the New England Anti-vivisection Society to prevent the former President from disposing of the funds of the Society. A lawsuit is, perhaps, the most innocent disposition that could be made of these funds.

FURTHER information has been sent concerning the Seventh International Geographical Congress, which will meet in Berlin at the end of September. Among the subjects to be brought up are: Proposal to introduce international uniformity in the methodical treatment of various subjects, such as the problem of the tides, the conventional signs on maps, the nomenclature and delimitation of oceans and seas, the attachment of the scale to every map, the mode of arranging meteorological tables, etc. There are also suggestions for joint international work: (1) in collecting materials of every kind referring to floating ice, to earthquakes, to the utilization of arid lands, etc.; (2) in the exploration of the Antarctic regions; (3) in the systematic exploration of the oceans; (4) a suggestion, dating from former congresses, and which is again to be discussed at Berlin, refers to the execution of an international geographical bibliography. It appears that this will be finally disposed of at Berlin. (5) Another important subject, dating from the meeting of Berne, is Professor Penck's well-known project for the construction of a map of the world on the scale of 1 to 1,000,000. It is intended also to make arrangements, if possible, for the more efficient work of the committees appointed by the Congress, as, for example, by paying for the traveling expenses of members in order that meetings may be held.

THE *British Medical Journal* reports that the first meeting of the 'Association des Anatomistes,' which is intended to form the nucleus of a 'Latin Anatomical Association,' was held recently in Paris, under the presidency of the distinguished embryologist, Professor Balbiani, of the Collège de France. The Vice-Presidents were Professors Mathias Duval, of Paris; Renaut, of Lyons, and Romiti, of Pisa. Professor Nicolas, of Nancy, was appointed Secretary, Professor Ranvier, of Paris, and Professor Van Bambeke, of Ghent, were elected Honorary Presidents, in addition to a considerable number of French teachers and investigators. Several foreign anatomists were present, including Professors Van der Stricht, of Ghent; Van Gehuchten, of Louvain, and Mitrophanoff, of Warsaw. The next meeting of the new Association will be held in connection with that of the Anatomical Section of the International Medical Congress to be held in Paris in 1900.

WE learn from the *British Medical Journal* that on February 2d a new Bacteriological Institute was formally opened in the University of Louvain. The Institute is on a large scale, and the installation and equipment are in accordance with the most advanced ideas. Every facility for research is provided. The stables, kennels and other quarters for animals are built around a vast garden, and all the arrangements show careful regard for the health and comfort of the animals. Professor Denys began his work fifteen years ago in two small rooms, which later expanded into a respectable laboratory, and now have developed into a scientific palace. Giving an account of the work that had been done, he stated that more than 80 original researches had come from it, besides 25 presented for travelling scholarships, 23 of which had gained a prize of £160. A special department in the new Institute will be devoted to the preparation of therapeutic serums of different kinds, tuberculin, etc. At the Congress on Tuberculosis held in Paris last summer Professor Denys gave an account of a new tuberculin which he had used with considerable success; he proposes to continue his work in this field, and is hopeful of success. A feature in the Institute which is likely to be particularly useful is an out-patient department for sufferers from tuberculosis and other microbic diseases who receive serum-therapeutic treatment adapted to their complaints, only substances which have been tested by experimentation on

animals being used. Already numbers of patients, mostly the subjects of phthisis, are in regular attendance.

UNIVERSITY AND EDUCATIONAL NEWS.

THE Trustees of Trinity College have decided to erect a Natural Science Hall at a cost of $40,000.

THE bi-centennial celebration of Yale University will begin on Sunday, October 20, 1901, and will continue for four days. On Wednesday a commemorative address will be made and honorary degrees will be conferred.

THE fund which since 1880 has been collecting for a retirement fund for professors of Harvard University has now reached $340,000, and the plan will be put into effect at the beginning of the next academic year. Professors who have served for twenty years and who are over sixty years old will be allowed one-third salary, with an increase for longer terms of service, which, however, is not to exceed two-thirds of the salary.

THE following table shows the enrollment of the University of Michigan, February 9, 1899:

Literary department	1,271
Engineering department	247
Medical department	421
Law department	745
Dental department	237
Homœopathic department	61
Pharmaceutical department	78
Total	3,060

A MEETING was held in London on January 31st for the purpose of forming the Cambridge University Association, the chief object of which is to improve the financial condition of the University. The Duke of Devonshire, Chancellor of the University, presided and made an address. Other addresses were made by Dr. Hill, the Vice-Chancellor; Professor Jebb, Master of Trinity; Sir Richard Webster, Professor Allbutt, Professor Ewing, Lord Rothschild and the Bishop of London. It was stated that the sum of about $2,500,000 was needed. Toward this sum the Duke of Devonshire and Lord Rothschild each subscribed £10,000. It was also stated that the Drapers' Company would subscribe £800 a year for ten years in support of a professorship of agriculture. Since the meeting Sir Walter Gilby has subscribed £200 for ten years for a readership of agriculture, and in addition to smaller subscriptions £3,000 toward the general fund has been given by Mr. Benjamin L. Cohen.

DR. J. C. BRANNER, professor of geology in Leland Stanford Jr. University, has been appointed Vice-President of the University.

THE chairs of pathology vacant at Cambridge, by the death of Professor Kanthack, and at Glasgow, by the death of Professor Coats, will be filled during March. In accordance with the English custom, applications for these chairs should be presented to the University authorities.

M. RIEFFEL-SCHIRMER, professor of geography at Lyons, has been appointed lecturer in the University of Paris for the present year, in the place of M. Gallois, who has been given leave of absence.

THE John Lucas Walker Studentship, of the annual value of £200, for the furtherance of original research in pathology, has been conferred upon Mr. Edward Sydney St. Barbe Sladen, M.A., M.D., B.C., of Gonville and Caius College. The studentship is tenable for three years.

DR. HÖLDER, professor of mathematics of the University at Königsberg, has been called to Leipzig, and will be succeeded at Königsberg by Dr. Schönflies, of Göttingen. Dr. Alois Lode has been made associate professor of hygiene at Innsbruck, and Dr. Helferich, of Greifswald, has been called to Kiel as successor to Professor v. Esmarch, who has retired. Dr. Otto Wiener, of Giessen, has been appointed to a full professorship of physics in the University at Leipzig, and Dr. Hans Held has been promoted to an assistant professorship of anatomy in the same University. Dr. Walter König has been appointed professor of theoretical physics in the University at Heidelberg, and Dr. Jakob Früh, professor of geography in the Polytechnic Institute at Zurich. Dr. Pelikan has been promoted to an assistant professorship of mineralogy in the German University at Prague.